GEMAC

Sensorik. Messtechnik. ASIC-Design.

User Manual

IPE1000 – U

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Revision Overview

Date	Revision	Change(s)
16:12.2003	1.0	First version
22.06.2004	1.1	Input connector pinning
02.07.2004	1.2	Output signal description, Soldering Jumper J10
21.01.2005	1.3	Input connector pinning
11.03.2005	1.4	Several changings
25.05.2005	1.5	Several changings
26.07.2011	1.6	Update

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Terms, Definitions and Abbreviations

1 Overview

The programmable interpolation unit IPE1000 – U has been designed for connection to incremental position and angle measuring systems with sine – shaped output signals with a 90° phase shift. It can be operated at a large number of transducer systems working according to the most varied measuring principles. With a maximum interpolation rate of 1000 the IPE1000 – U is capable to split the input signal period into up to 1000 segments. An RS422 interface for square wave output is available.

Proprietary automatic gain and offset control, as well as the possibility of a analogue phase correction of the internal GC – IP1000 ensure a high measuring precision under industrial conditions.

Block diagram

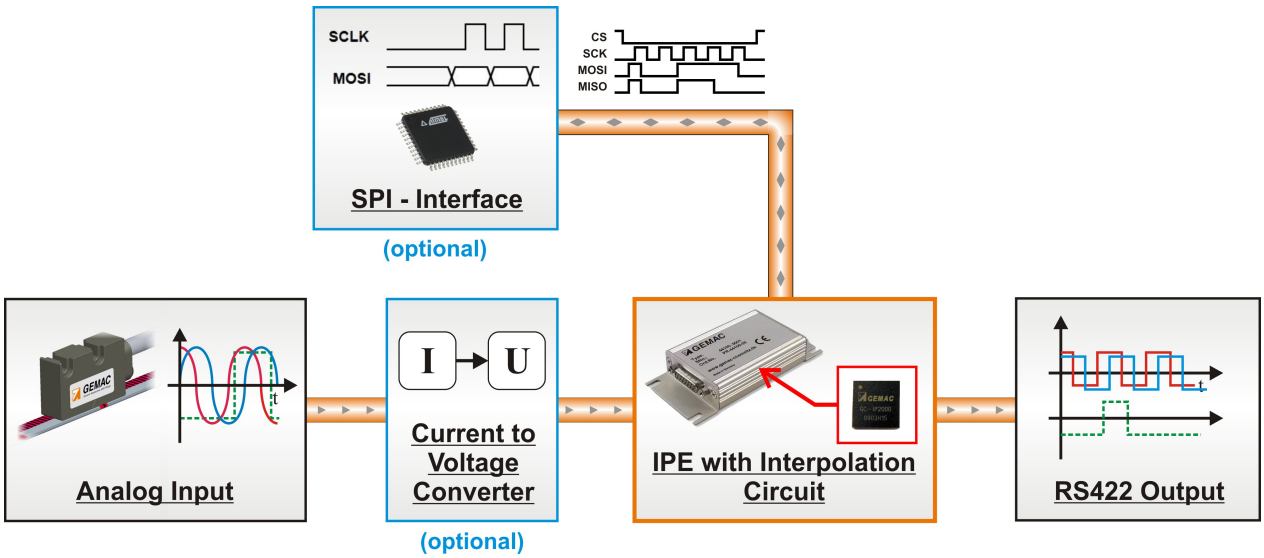

Figure 1: Block diagram

2 Input Signals

The input signals of the IPE1000 – U are analogue voltages (sine / cosine), which have a sine – shaped dependency on the measured value (position or angle). The phase shift between those two analogue voltages is 90°, related to one period of the scale. A third input signal serves the zero or reference point of the scale as a reference signal for determining. All the tree input signals are processed as differential or single ended signals. Another version of the device with current inputs is also available (IPE1000 – I).

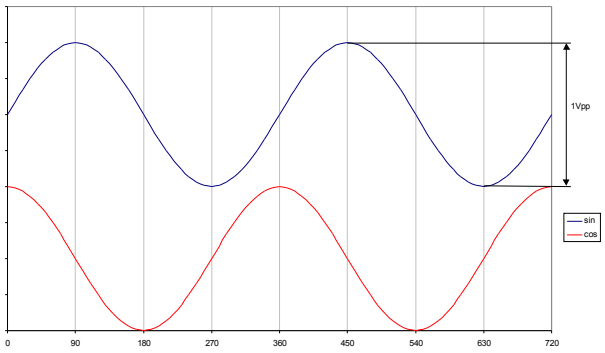

Figure 2: Input signals single – ended

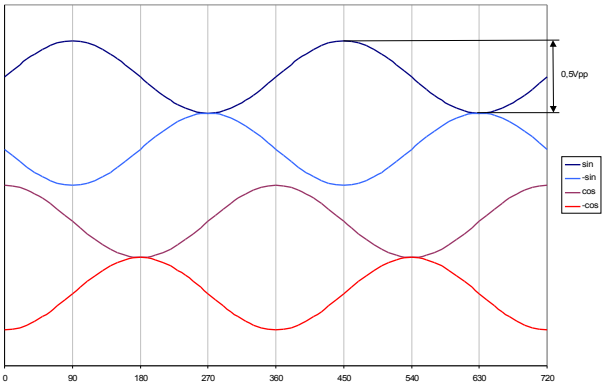

Figure 3: Input signals differential

2.1 Connection of a Measuring System

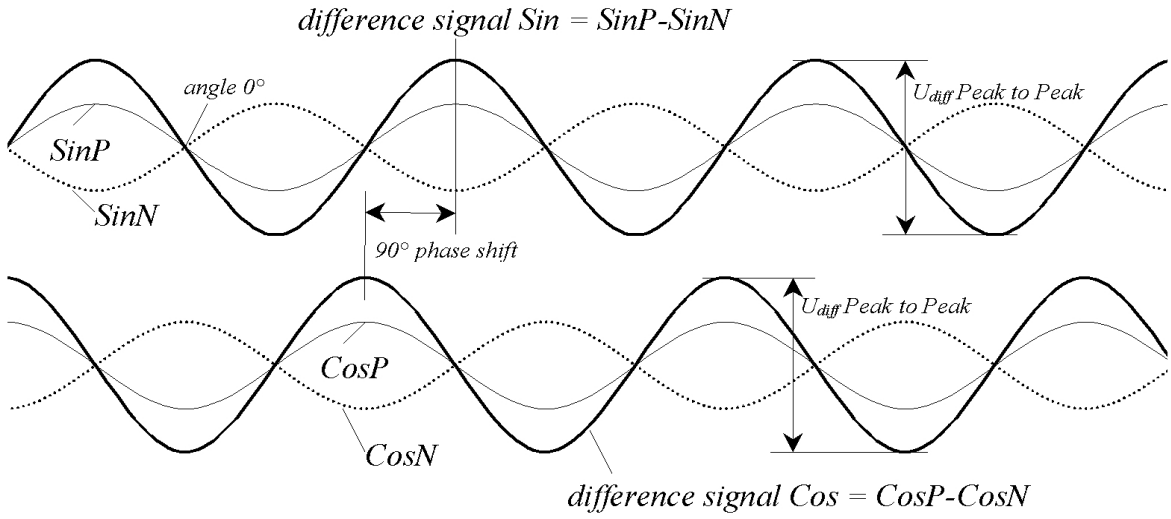

Figure 4: Connection of a measuring system

G1	G0	Gain (nominal)	Input voltage for differential input [1]	Input voltage U_{Diff} (nominal)	Input voltage range for U_{Diff}	Maximum Signal offset
offen	zu	19,5	50 mV_{pp}	100 mV_{pp}	80 mV_{pp} … 120 mV_{pp}	± 10 mV
offen	offen	16,25	60 mV_{pp}	120 mV_{pp}	96 mV_{pp} … 144 mV_{pp}	± 12 mV
zu	zu	13,45	72 mV_{pp}	145 mV_{pp}	145 mV_{pp} … 174 mV_{pp}	± 14,5 mV
zu	**offen**	**1,95**	**0,5 V_{pp}**	**1 V_{pp} (Default)**	0,8 V_{pp} ...1,2 V_{pp}	± 100 mV

[1] at each of the inputs SINP, SINN, COSP, COSN

Table 1: Gain (See also chapter 7.3)

2.2 Signal Correction

The input signals are subject to the internal automatic gain and offset control of the IP1000, which is patented by GEMAC. The amplitude controller is specified for a control range of ± 20 % of nominal input voltage. The offset of the external signals must not exceed a value of ± 10 % of nominal input voltage. The phase shift of the input signals can be adjusted statically by the internal potentiometer in a range of ± 6° or ± 12° via SPI. There are two measuring points (MP1 and MP2) for testing the signals. The signal at each of those measuring points should have an amplitude of 2.0 V_{PP} and an offset of 2.275 V refering to Ground.

For achieving the best interpolation performance, the gain – offset – controller needs approximately 20 signal periods for reaching a steady state. Until this time, the input signal frequency must not exceed 50 % of the specified maximum signal frequency (please refer to chapter **4.1**)

Note:

For reaching the highest accuracy of the gain – offset regulation the phase should adjust. This will be very important if high interpolation rates are used.

2.3 Reference Signal

A third output of the measuring system - typically called reference, index point or zero point signal – will be considered to be activated, if the difference of the signals at the **REFP** and **REFN** pins becomes bigger than the positive hysteresis voltage V_{RPH} and will be considered to be deactivated if this voltage becomes smaller than the negative hysteresis voltage V_{RPL}.

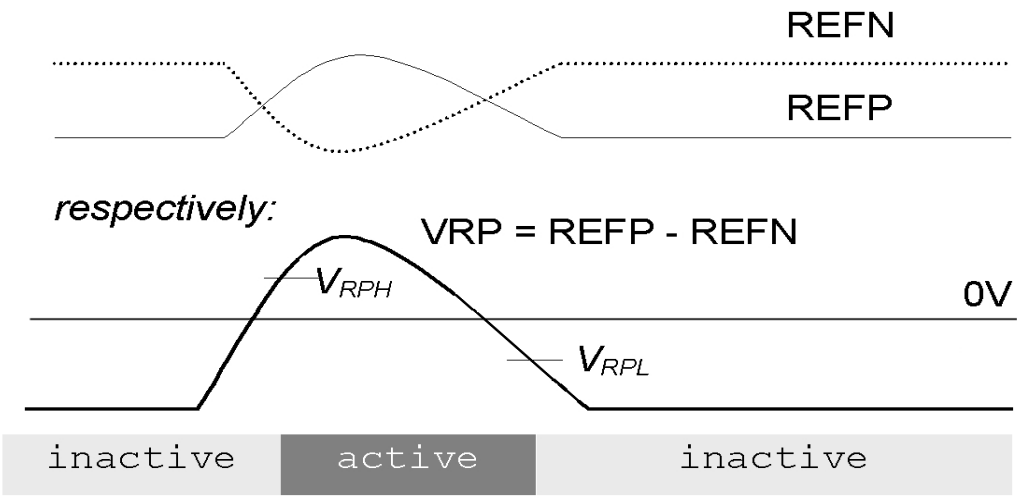

Figure 5: Reference signal

V_{RPL} (typ.) = - 30 mV

V_{RPH} (typ.) = + 30 mV

Note:

If a sensor without reference signals is used, defined levels on pins REFP and REFN are necessary to set the index point always active or always inactive.

Reference signal at the output active in each period	Reference signal at the output inactive
LJ 19: b – c	LJ 19: a – b
LJ 18: open	LJ 18: open
R11: placed	R11: placed

Table 2: Reference Signal internal

3 Output Signals

3.1 Output Signals RS422

The output signals are phase shifted square wave sequences (known by incremental measuring transducers). They can be counted in a single or quadruple way. A synchronous reference pulse will be generated when the angle of 0° (refer also to Figure 4) is passed through and when the analogue differential input voltage between REFP and REFN exceeds the positive comparator hysteresis level. If the differential input voltage is permanently above this level, the reference pulse will be generated once during every signal period.

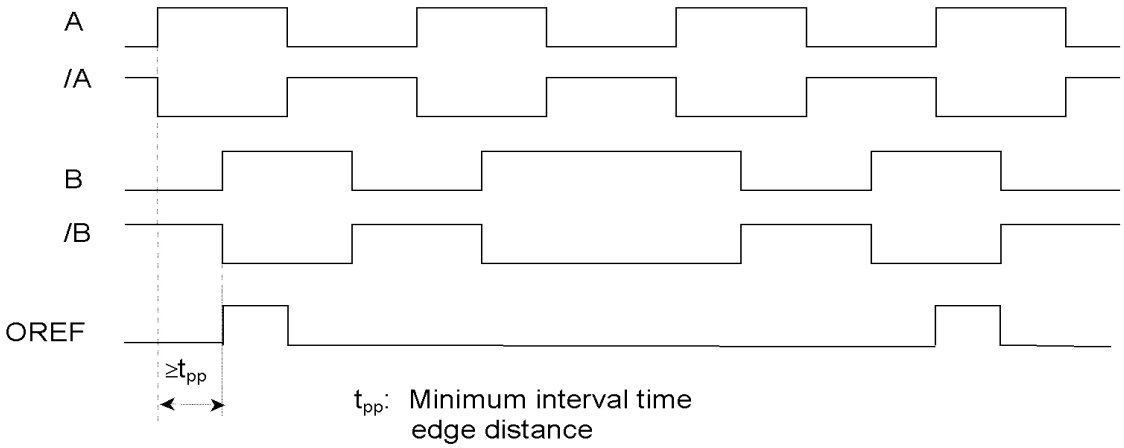

Figure 6: Output signals

For generating a reference pulse at the output and the exact assignment of the signals A, B and OREF it is necessary to pass a Sin / Cos – period (for finding the zero degree angle). That status will be signalized by a green Valid – LED (locked status). In the case of an error the red Error – LED is switched on and the green Valid – LED is switched off. An external reset pulse with a minimum length of 3 µs will restart the GC-IP200. To get the locked status again a further Sin / Cos – period is needed.

Note:

In case of selected interpolation rates 125 and 250 – fold the assignment of A, B and OREF can not be guaranteed.

3.2 Error Signal

An error signal will be generated if the input signals are plausible no longer. The error signal will also be generated if the input frequency is so high that the square-wave signals are unable to follow, and/or when the maximum input frequency is exceeded.

Note:

If the error signal was activated, and/or if one of the error bits was set in the result register, the present measuring result and all the following results would have to be discarded. Following elimination of the cause of the error and a reset of the error bit, the reference point has to be passed by for absolute value measurements once again!

4 Interpolation Rate

The interpolation rate can be set at 1000, 800, 500, 400, 250, 200, 125 and 100. The Interpolation rate as defined for the purpose of this application is the number of increments into which one sine period of the input signal is divided. This also corresponds to the number of edges changes on the A / B output signals per input signal period. This means that the number of square – wave periods at the A and B outputs totals ¼ of the interpolation rate per input signal period.

Note:

In the case that a standard interpolation counter or quadrature decoder is connected to the A / B outputs, this has to work in "quadruple evaluation" mode in order to achieve the full interpolation rate.

4.1 Interval Time / Maximum Input Frequency

The interval time (IT) respectively the minimum edge distance (t_{PP}) at the output signals can be adjusted using the same DIL – Switch as for the interpolation rate. This is possible from $1/f_{osc}$ to $128/f_{osc}$ in binary steps.

The following table shows the maximum input frequencies under consideration of the interval times.

				f_{OSZ} = 22 MHz				f_{maxCNT} = 110 kHz							
IR	IT	t_{pp}	f_{max}	IR	IT	t_{pp}	f_{max}	IR	IT	t_{pp}	f_{max}	IR	IT	t_{pp}	f_{max}
1000	1	45 ns	19 k	800	1	45 ns	25 k	500	1	45 ns	40 k	400	1	45 ns	50 k
	2	91 ns	10 k		2	91 ns	12,5 k		2	91 ns	20 k		2	91 ns	25 k
	4	181 ns	5 k		4	181 ns	6,2 k		4	181 ns	10 k		4	181 ns	12,5 k
	8	363 ns	2,5 k		8	363 ns	3,1 k		8	363 ns	5 k		8	363 ns	6,2 k
	16	727 ns	1,2 k		16	727 ns	1,5 k		16	727 ns	2,5 k		16	727 ns	3,1 k
	32	1,4 µs	600		32	1,4 µs	775		32	1,4 µs	1,2 k		32	1,4 µs	1,5 k
	64	2,9 µs	300		64	2,9 µs	380		64	2,9 µs	600		64	2,9 µs	775
	128	5,8 µs	150		128	5,8 µs	190		128	5,8 µs	300		128	5,8 µs	380
250	1	45 ns	80 k	200	1	45 ns	100 k	125	1	45 ns	110 k	100	1	45 ns	110 k
	2	91 ns	40 k		2	91 ns	50 k		2	91 ns	80 k		2	91 ns	100 k
	4	181 ns	20 k		4	181 ns	25 k		4	181 ns	40 k		4	181 ns	50 k
	8	363 ns	10 k		8	363 ns	12,5 k		8	363 ns	20 k		8	363 ns	25 k
	16	727 ns	5 k		16	727 ns	6,2 k		16	727 ns	10 k		16	727 ns	12,5 k
	32	1,4 µs	2,5 k		32	1,4 µs	3,1 k		32	1,4 µs	5 k		32	1,4 µs	6,2 k
	64	2,9 µs	1,2 k		64	2,9 µs	1,5 k		64	2,9 µs	2,5 k		64	2,9 µs	3,1 k
	128	5,8 µs	600		128	5,8 µs	775		128	5,8 µs	1,2 k		128	5,8 µs	1,5 k

Table 3: Clock frequency example

Note:

These values apply on condition of an adjusted phase between the input signals and a steady state of the internal gain – offset – controller. Until this time, the input frequency must not exceed 50 % of the specified maximum frequency.

4.2 Glitch Filter

In order to avoid permanent toggling of the downstream counters as a result of analogue noise of the input signals while the measuring system is in standstill, a digital filter can be optionally activated for the square-wave outputs (pin / bit GFE). In such a case, the minimum edge distance at the output (t_{pp}) is then automatically set at 1024 / f_{OSC} while the measuring system is in standstill or at smaller input frequencies.

Note:

Note that in the switching range to the automatic activation / deactivation of this filter, the A / B output signals are not speed – proportional in each case!

LJ10 – jumper for glitch filter	descriprion
open	glitch filter active
closed	glitch filter inactive

Table 4: Glitch filter (refer to chapter 7)

5 Specifications

Characteristic values				
Recommended Operating Conditions	**Min.**	**Nom.**	**Max.**	**Unit**
Supply voltages	4.75	5.0	5.25	V
Supply current		130		mA
Operating case temperature	- 20		80	°C
Analog Input Specifications	**Min.**	**Nom.**	**Max.**	**Unit**
Input frequency			110	kHz
Phase offset between SIN and COS (100 kHz)		90		°
Peak to Peak input voltage SINN ⇔ SINP / COSN ⇔ COSP	0.8	1.0	1.2	V_{pp}
Phase deviation	± 8	± 10	±12	°
Oscillator frequency		20		MHz
Reset Specifications	**Min.**	**Nom.**	**Max.**	**Unit**
Reset impulse length	3			µs
Interpolation	**Min.**	**Nom.**	**Max.**	**Unit**
Interpolation Rates	100 / 125 / 200 / 250 / 400 / 500 / 800 / 1000			
Minimum interval time A / B – Signals	1 / fosz		128 / fosz	ns
Interpolation accuracy		± 0.7		Inc.
Propagation delay square – wave outputs (A / B / OREF)		122 / fosz		ns
Other characteristics	**Extruded aluminium housing**		**die – cast box housing**	
Degree of protection (depends on the housing)	IP20		IP65	
Connector	SUB – D 15-pin		Round plug 9- und 12-pin	
Dimensions	55 mm x 80 mm x 20 mm		100 mm x 66 mm x 50 mm	

Table 5: Specifications

6 Configuration of the Switches and Connectors

It is necessary to open the unit for configuration. This can be done by open the screws at both sides. The cover can be lift off now.

6.1 Extruded Aluminium Housing IP20

Signal input SUB – D 15-pin; female	
Pin No.	**Signal**
1	SINP
2	0 VDC
3	COSP
4	+ 5 VDC
5	
6	
7	REFN
8	
9	SINN
10	0 VDC
11	COSN
12	+ 5 VDC
13	
14	REFP
15	

Signal output SUB – D 15-pin; male	
Pin No.	**Signal**
1	AP
2	0 VDC
3	BP
4	+ 5 VDC
5	EP
6	
7	ZN
8	
9	AN
10	0 VDC
11	BN
12	+ 5 VDC
13	ext. trigger
14	ZP
15	EN

Table 6: Signal input / Signal output IP20

6.2 Die – cast Box Housing IP65

Round plug 9-pin (Signal input)	
Pin No.	**Signal**
1	SINN
2	SINP
3	+ 5 VDC
4	0 VDC
5	COSN
6	COSP
7	REFN
8	REFP
9	PE

Round plug 12-pin (Signal output)	
Pin No.	**Signal**
1	AN
2	AP
3	BN
4	BP
5	ZN
6	ZP
7	EN
8	EP
9	+ 5 VDC
10	0 VDC
11	external trigger
12	–

Table 7: Signal input / Signal output IP65

6.3 DIL – Switch

Switch No.	Signal Name		On	Off
1	IR0	Interpolation rate	See table interpolation rate (**Table 9**)	
2	IR1			
3	IR2			
4	IT0	Minimum edge distance at the outputs	See table edge distance (**Table 10**)	
5	IT1			
6	IT2			

Table 8: DIL – Switch

6.4 Interpolation Rate

IR2	IR1	IR0	Interpolation rate
OFF	ON	ON	1000
ON	ON	ON	800
OFF	ON	OFF	500
ON	ON	OFF	400
OFF	OFF	ON	250
ON	OFF	ON	200
OFF	OFF	OFF	125
ON	OFF	OFF	100

Table 9: Interpolation rate

6.5 Minimum Edge Distance at the Outputs

IT2	IT1	IT0	Intervallzeit 1 / fosz
ON	ON	ON	1
ON	ON	OFF	2
ON	OFF	ON	2
ON	OFF	OFF	8
OFF	ON	ON	16
OFF	ON	OFF	32
OFF	OFF	ON	64
OFF	OFF	OFF	128

Table 10: Minimum edge distance at the outputs

6.6 Service connector SPI

Pin No.	Signal
1	SDO
2	SDI
3	SCLK
4	SCEN
5	NERR
6	NRES
7	GND
8	GND
9	VDD
10	VDD

Table 11: Service connector SPI

6.7 LED

LED	Meaning
LED 1	Power supply
LED 2	Error LED (see chapter **4**)
LED 3	Looked LED (see chapter **4**)
LED 4	Reset

Table 12: LED

7 Component Mounting Diagram

7.1 Component side

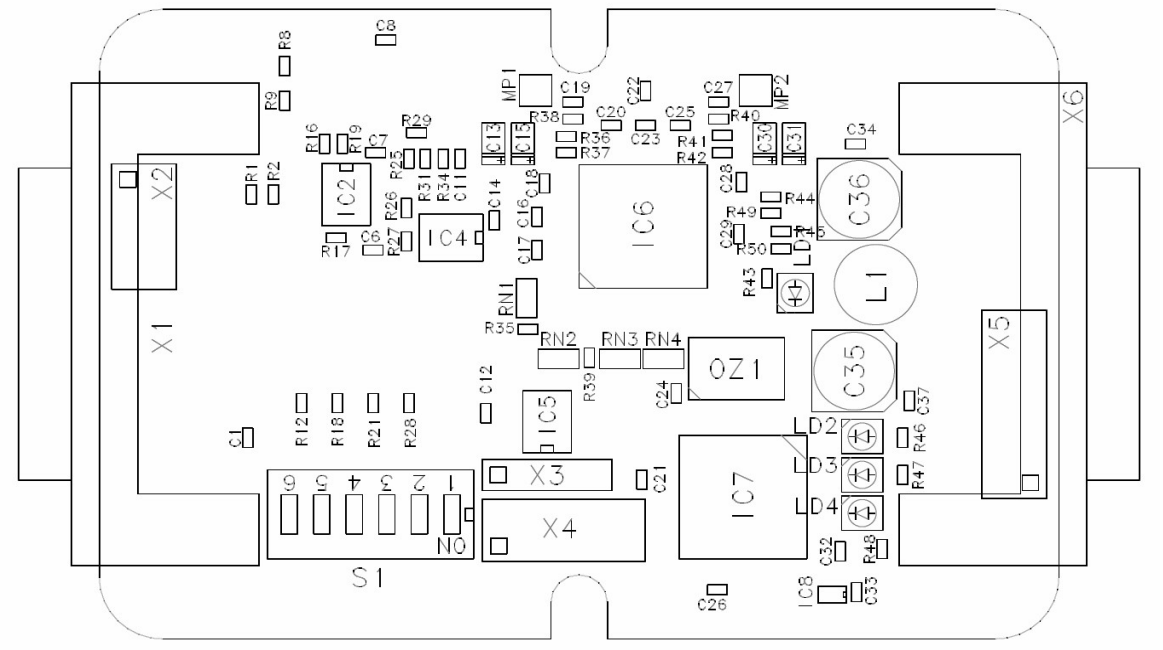

Figure 7: Component side

7.2 Soldering side

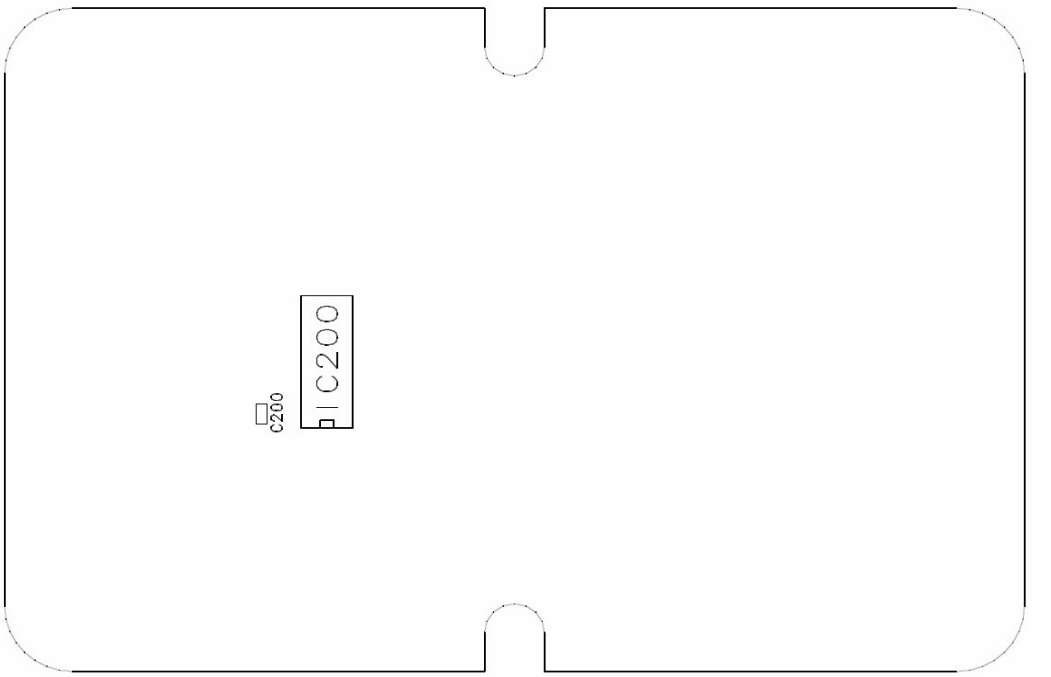

Figure 8: Soldering side

7.3 Soldering Jumper

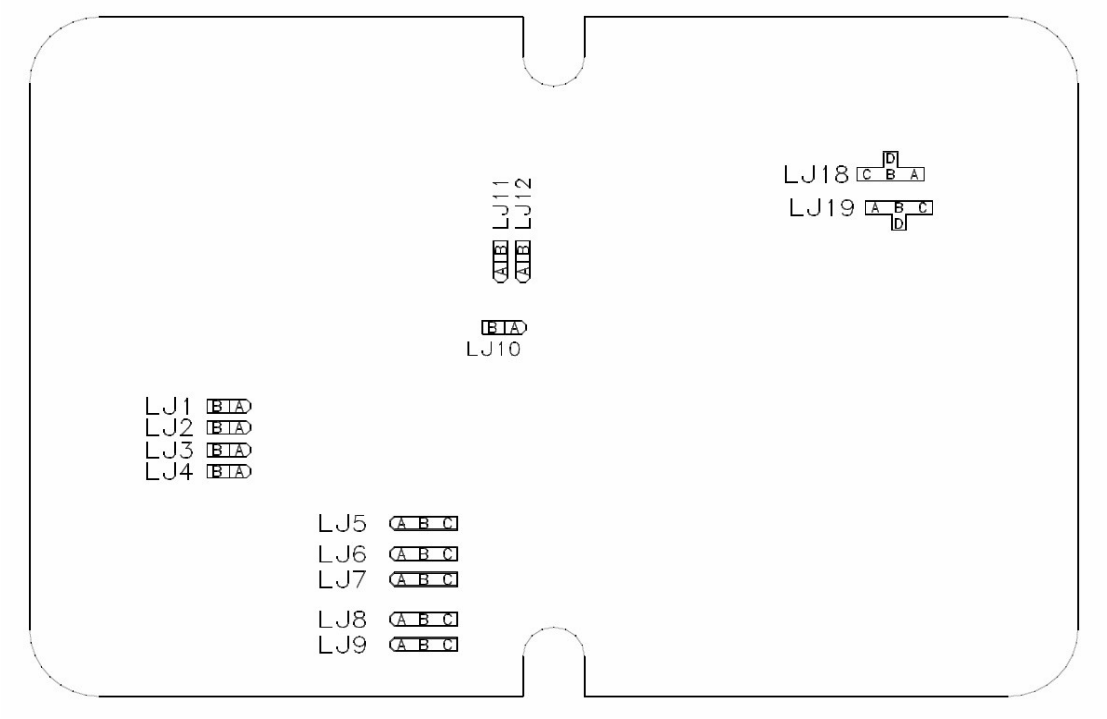

Figure 9: Soldering jumper

7.4 Gain adjustment

Jumper for gain adjustment	Signal
LJ 11	G0
LJ 12	G1

Table 13: Gain adjustment

7.5 Gain

G0	G1	Verstärkung
close	open	19,5
open	open	16,2
close	closed	13,4
open	**closed**	**1,95 (default)**

Table 14: Gain

7.6 Dimensions

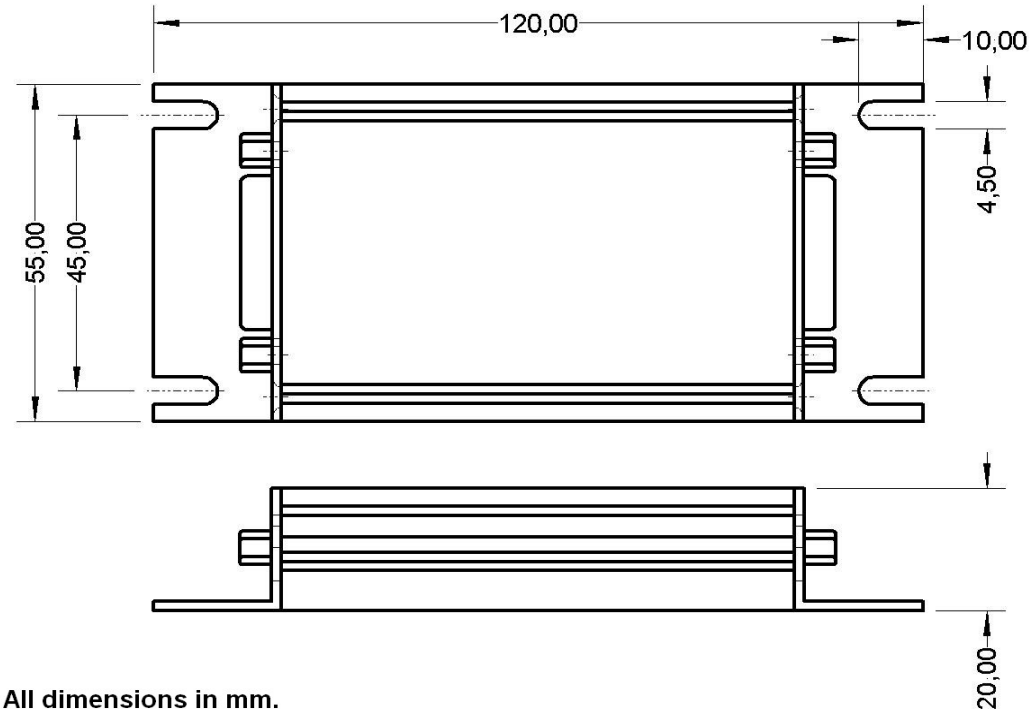

Figure 10: Dimensions IPE1000

8 Notes